Center Independent Research & Development: KSC IRAD

Advanced Solid State Lighting for Human Evaluation

Completed Technology Project (2014 - 2015)

Project Introduction

Lighting intensity and color have a significant impact on human circadian rhythms. Advanced solid state lighting was developed for the Advanced Exploration System (AES) Deep Space Habitat (DSH) concept demonstrator. The latest generation of assemblies using the latest commercially available LED lights were designed for use in the Bigelow Aerospace Environmental Control and Life Support System (ECLSS) simulator and the University of Hawaii's Hawaii Space Exploration Analog and Simulation (Hi-SEAS) habitat. Agreements with both these organizations will allow the government to receive feedback on the lights and lighting algorithms from long term human interaction.

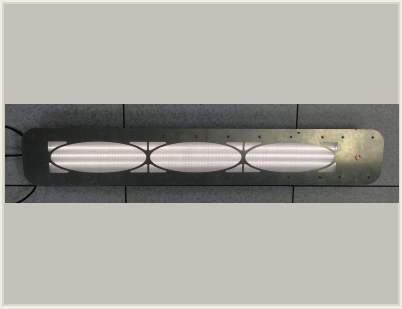
Sleep has a significant impact on the human circadian rhythm. Bright light and blue light suppress the amount of melatonin, a sleep hormone, in the human organism. The latest generation of advanced solid state lighting combines characteristics of normal terrestrial diurnal illumination with that of a normal crew day as scheduled by the AES DSH program. Lighting goes from a twilight/nightlight mode and brightens as the crew goes through it's morning awakening activities. The light becomes gradually brighter and cooler as crew approaches the nominal work day, maximum brightness peaking at a color temperature of 5500K. As the work day comes to a close, and crew moves into their post work/social/rest period the light slightly dims and significantly warms approaching a color temperature of 3000K. (Cool light corresponds to a greater color temperature and warmer light to a lower color temperature.) When the crew prepares for the sleep cycle part of the day, the light dims yet to a twilight/nightlight state.

The current lights are fully addressable and reprogrammable through a USB interface, allowing medical personnel to adjust each individual light to the needs of each crew members sleep needs. Lighting can be gradually adjusted to assist with shifting crew circadian rhythm. In the event on one member of the crew experiencing a sleep disorder, lights can be adjusted to assist with overcoming this difficulty - a lighting prescription. Each light also has several preselected modes enabled through direct interaction with the fixture.

Agreements with the University of Hawaii and Bigelow Aerospace will allow the government to receive feedback on the current algorithms with minimal investment. Hi-SEAS feedback from initial prototype units has already resulted in adjustments to the remote interface design. It is expected feedback from human interaction will result in additional refinements to both the interface, lighting algorithm, and overall assembly.

Anticipated Benefits

Lighting and active lighting regimes can assist in overcoming crew sleep disorders and help with shifting crew circadian rhythms as needed.



Lighting Prototype for the Bigelow BA330 ECLSS simulator

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Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Independent Research & Development: KSC IRAD

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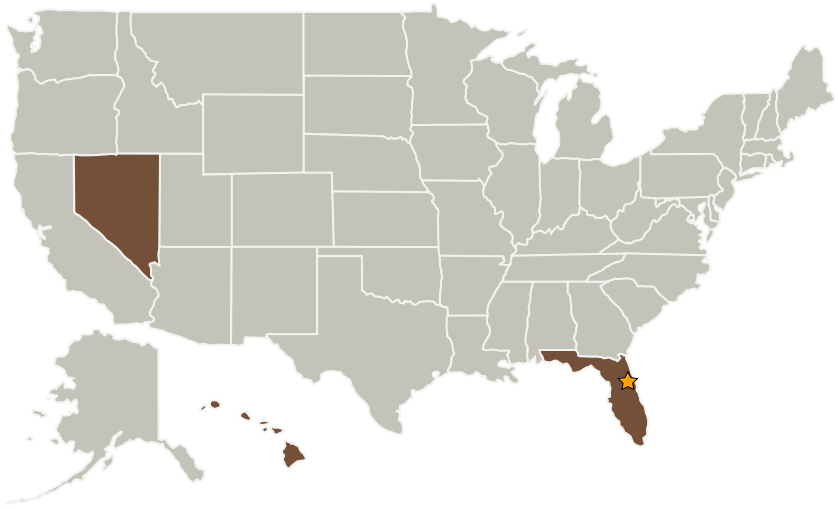
Deep space habitation will require a well regulated circadian schedule through healthy sleep habits and patterns.

All long term space human habitation will benefit from regulated circadian rhythm systems.

Any government agency with shift workers can benefit from this technology. Cool, bright light will help concentration and gradual changes can enable those same workers to transition to their rest period easier.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Bigelow Aerospace(BA)	Supporting Organization	Industry	
University of Hawaii Maui College	Supporting Organization	Academia	Kahului, Hawaii

Project Management

Program Manager:

Barbara L Brown

Project Manager:

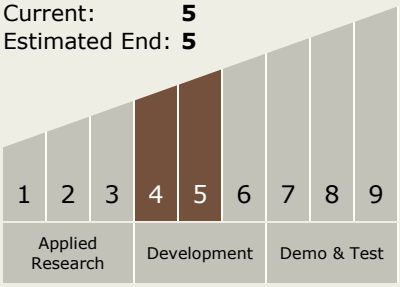
Nancy P Zeitlin

Principal Investigator:

Eirik Holbert

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.1 Environmental Control & Life Support Systems (ECLSS) and Habitation Systems
    - TX06.1.4 Habitation Systems

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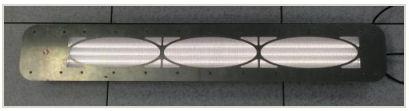
Co-Funding Partners	Type	Location
Bigelow Aerospace(BA)	Industry	
University of Hawaii Maui College	Academia	Kahului, Hawaii

Primary U.S. Work Locations	
Florida	Hawaii
Nevada	

Images



Advanced Lighting Prototype
Lighting Prototype for the Bigelow BA330 ECLSS simulator
(https://techport.nasa.gov/image/16537)